The Journal of Emergency Medicine, Vol. 74, No. C, pp. 23–48, 2025
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0736-4679/$ - see front matter

https://doi.org/10.1016/j.jemermed.2025.02.010

Clinical Reviews

The Impact of Mass Gatherings and Events on Emergency Department Admissions: A Systematic Literature Review

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□ **Abstract—Background: Mass gatherings, including major sporting events, music festivals, and other large gatherings, are integral to cultural and social life but can significantly impact local healthcare services. Understanding the effect of these events on emergency department (ED) admissions is crucial for effective resource planning and public health preparedness. Objectives: This systematic literature review (SLR) aims to investigate the influence of mass gatherings on ED admissions, focusing on the overall and category-specific ED metrics associated with these events. Methods: Following PRISMA guidelines, we conducted a comprehensive database search spanning 2012–2024 using PubMed, EMBASE, Web of Science, ProQuest, Scopus, Springer, Cochrane Library, and Science Direct. We identified 14 relevant studies on mass gatherings and ED presentations from various countries. BERT natural language processing and manual screening were used to achieve over 90% efficiency in excluding irrelevant articles. Results: Fourteen studies show ED visits vary during mass gatherings: some events see 7.5–37% drops, while others, especially music festivals and religious gatherings, reach spikes up to 83% (during Umrah). Substance-related cases rise (up to 10%), trauma accounts for up to 34%, and surges often occur 4–12 hours postevent. Music festivals feature more substance-related cases, while religious gatherings see higher medical and respiratory admissions. Conclusions: The findings indicate varying impacts on ED utilization during mass gatherings, with some events showing fewer overall visits and others reporting spikes, particularly in trauma and substance-related cases. The review highlights the need for postevent surge preparedness, advocating coordinated planning with organizers and targeted public health interventions.** **© 2025 The Author(s). Published by Elsevier Inc. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/)**

□ **Keywords—mass gatherings; sports events; emergency department; systematic literature review**

Introduction

Emergency departments (EDs) serve as critical entry points to healthcare systems, often operating under significant stress due to fluctuating patient volumes (1–5). Among the factors affecting ED attendance, mass gatherings (MGs) events attracting over 1000 people—pose unique challenges, including the potential for disease importation and an increased burden of injury-related presentations (6,7). These large-scale social, cultural, or sporting events can strain local health services (8), especially EDs already coping with overcrowding and resource constraints (1,4).

Existing studies indicate diverse impacts of MGs on ED admissions. Some suggest that overall ED presentations decline during events due to fewer low-acuity visits (8–11). Other work shows increased presentations for

RECEIVED: 10 November 2024; FINAL SUBMISSION RECEIVED: 7 January 2025;
ACCEPTED: 3 February 2025

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IT

substance misuse, trauma, or cardiac conditions (12–15). Sporting tournaments, music festivals, religious gatherings, and public holidays each exhibit distinct patient profiles (16,17). For example, heavy alcohol consumption at music festivals can heighten the incidence of injuries and substance-related ED admissions (18–20), whereas the increased pilgrimage activity in Makkah during Ramadan can shift ED presentations toward conditions such as cardiac or respiratory problems (17). The World Health Organization (WHO) underscores that large gatherings can rapidly overburden health infrastructures, necessitating targeted preparedness (21,22).

Despite the emerging body of evidence, little synthesis has consolidated these varied findings on how MGs affect overall and condition-specific ED admissions. This systematic literature review (SLR) addresses that gap, offering a comprehensive view of MG-associated ED usage patterns worldwide. A novel aspect of this review is incorporating BERT (Bidirectional Encoder Representations from Transformers) for literature screening—a technique shown to expedite article identification with high accuracy (23–25). BERT's efficiency resulted in over 90% accuracy in excluding irrelevant studies, significantly reducing the review time compared to traditional methods, while manual screening ensured that no relevant studies were overlooked. BERT's semantic analysis capabilities allowed for the comprehensive identification of studies on the effects of events on ED admissions, ensuring the inclusion of diverse research from global contexts.

The remainder of the current review is structured as follows: Section 2 outlines the methods employed in conducting the review. Section 3 discusses the bias assessment of the included studies. Section 4 presents the results of our analysis. Sections 5 and 6 discuss the findings, implications for future research, and study limitations. Finally, Section 7 offers the concluding remarks.

Methods

Search Strategy

This systematic review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. A comprehensive search strategy was designed to identify studies investigating the association between mass gatherings and ED admissions. Several databases were used: PubMed, EMBASE, Cochrane Library, Google Scholar, Web of Science, ProQuest, Scopus, Springer, and Science Direct. Additionally, the authors conducted a manual search of abstracts and titles within the specified databases to ensure thorough coverage of relevant literature using combinations of the following terms: "emergency department," "ED," "hospital admissions," "patient volume," "mass gatherings," "crowd events," "events," "sporting events," "concerts," "festivals," "public holidays." This SLR was registered on PROSPERO under the registration number 'CRD42024523375'.[1] Further details about keywords and search strings are available in Appendix A.

Eligibility Criteria

The included studies were observational designs published between 2012 and December 2024, all examining ED admissions related to MGs and events. These events included sporting matches, festivals, public holidays, concerts, and mass participation sporting events. The studies encompassed cases worldwide, with ED data from medical records, hospital databases, or insurance claims. Most studies compared ED admissions before, during, and after events to a control period. The inclusion and exclusion criteria are outlined in Table 1. After removing duplicates and screening titles and abstracts, 23 articles underwent full-text review. Following the full-text screening, fourteen studies remained. These eleven studies met the eligibility criteria and were included in the systematic literature review (SLR). A PRISMA flowchart is provided below in Figure 1.

Study Selection

This systematic literature review followed the PRISMA guidelines to ensure a rigorous and transparent selection process. The focus was observational studies published between January 2012 and December 2024 that examined emergency department (ED) admissions related to sporting matches, festivals, public holidays, concerts, and mass participation sporting events. To compile a comprehensive dataset, studies were included if they sourced ED data from medical records, hospital databases, or insurance claims, ensuring robust and verifiable information. The selection emphasized studies that provided comparative analyses of ED admissions before, during, and after these events against a control period, allowing for assessing the impact on ED usage. The initial screening involved evaluating 3309 potentially relevant records. To streamline this process, the Bidirectional Encoder Representations from Transformers (BERT)

[1] SeyedAli PoshtMashhadi, Lincoln C. Wood, Abtin Ijad Maghsoodi. The Impact of Special Events on Emergency Department Admissions: A Systematic literature review. PROSPERO 2024 CRD42024523375 Available from: https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42024523375.

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Table 1. Inclusion/Exclusion Criteria for Full-Text Studies.

Author(s)	Year	Location	Event Type	Reason for Inclusion/Exclusion	Inclusion
Lloyd et al. (26)	2012	Melbourne, Australia	MG	Focuses only on alcohol intoxication	Excluded
Kim et al. (27)	2012	United States	Sporting event	Provides results on the effects of special events on ED admissions	Included
Cherpitel et al. (28)	2012	Multiple countries	Alcohol-related events	Focuses only on alcohol intoxication	Excluded
Elliot et al. (7)	2012	United Kingdom	Sporting event	Does not provide enough numerical results on ED admissions type or number	Excluded
Miller et al. (29)	2013	Australia	Sporting event	Focuses only on alcohol intoxication	Excluded
Zroback et al. (30)	2014	Cape Town, South Africa	Sporting event	Provides results for both effects of special events on ED admission and type of admissions	Included
Callaghan et al. (31)	2014	Ontario, Canada	Birthday party	Focuses only on alcohol intoxication	Excluded
Almeida et al. (32)	2014	Lisbon, Portugal	Sporting event	Provides results on the effects of special events on ED admission	Included
Gardener et al. (33)	2015	New Zealand	Sporting event	Provides results for both effects of special events on ED admission and type of admissions	Included
Feldman et al. (34)	2016	Toronto, Canada	MG	Excluded as focuses solely on special events effect	Excluded
Wong et al. (18)	2017	Canada	Calgary Stampede	Inclusion due to its focus on ED crowding and trauma during a mass gathering event	Included
Luther et al. (19)	2017	Australian Capital Territory	Music festival	Provides results for type of ED admissions during outdoor music festival	Included
Hughes et al. (8)	2018	England, France, Northern Ireland	Sporting event	Provides results for both the effects of special events on ED admission and type of admissions	Included
Castro-Marin et al. (35)	2018	Arizona, United States	MG	Excluded as focuses solely on mobile ED transport	Excluded
DeMott et al. (36)	2018	United States	Mass Gathering	Provides results on patient presentations to ED from mass gathering events	Included

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Table 1. (*continued*)

Author(s)	Year	Location	Event Type	Reason for Inclusion/Exclusion	Inclusion
M.G. Friedman et al. (20)	2018	North-eastern United States	MG	Provides results for type of ED admissions during outdoor music festival and campus-wide celebration	Included
Peña et al. (37)	2020	Spain	Sporting event	Provides results for the effects of special events on ED admissions	Included
Johnston et al. (16)	2020	Australia	ED event avoidance	Inclusion due to focus on reducing ED admissions and improving flow during events	Included
Ranse et al. (15)	2019	Canberra, Australia	Outdoor Music Festival	Provides results on the impact on in-event, ambulance, and ED services from a mass gathering event	Included
Almalki et al. (17)	2021	Saudi Arabia	Mass Gathering (Umrah Pilgrim)	Inclusion due to relevance in analysing ED and ICU admissions during a religious mass gathering	Included
Rostami-Tabar et al. (38)	2022	United Kingdom	MG	Proposes method to forecast ED, no estimation	Excluded
Koski et al. (14)	2022	Finland	MG	Provides results for both effects of special events on ED admission and type of admissions	Included

MG = mass gathering; ED = emergency department; I = intensive care unit.

model was utilized to assess semantic textual similarity between study titles and abstracts and the research keywords (23). This approach helped automate the screening by identifying and excluding less relevant articles based on their semantic similarity to the research topic.

This phase involves two primary objectives: a Masked Language Model (MLM) and Next Sentence Prediction (NSP). In MLM, segments of the input text are randomly masked, prompting the model to predict these masked words based on their contextual surroundings. Meanwhile, NSP focuses on discerning whether two sentences are consecutive. This diverse training helps the model grasp relationships between sentences, enhancing its ability to capture the intricacies of language structure. BERT excels at encoding words or sentences into numerical representations, capturing their semantic meanings. To measure text similarity between reference keywords and the combination of each study's title and abstract, BERT uses several steps. Details of the algorithm and the steps it uses are outlined in Appendix B. The model visually depicts the systematic article selection and exclusion process, ensuring a methodical approach to identifying pertinent literature for the SLR. This approach is based on literature showing that document embeddings from pretrained language models can effectively measure semantic similarity for retrieval and classification (24). The goal is to automate the screening process by removing less relevant articles based on their semantic similarity to the research topic's keywords. Prior studies have explored similar techniques of using document embeddings to reduce workload in SLRs (25).

Recognizing that some relevant studies might be overlooked due to lower similarity scores, a hybrid approach was implemented. Reviewers reviewed articles excluded by BERT to ensure that all pertinent studies were included. This combined method significantly reduced the

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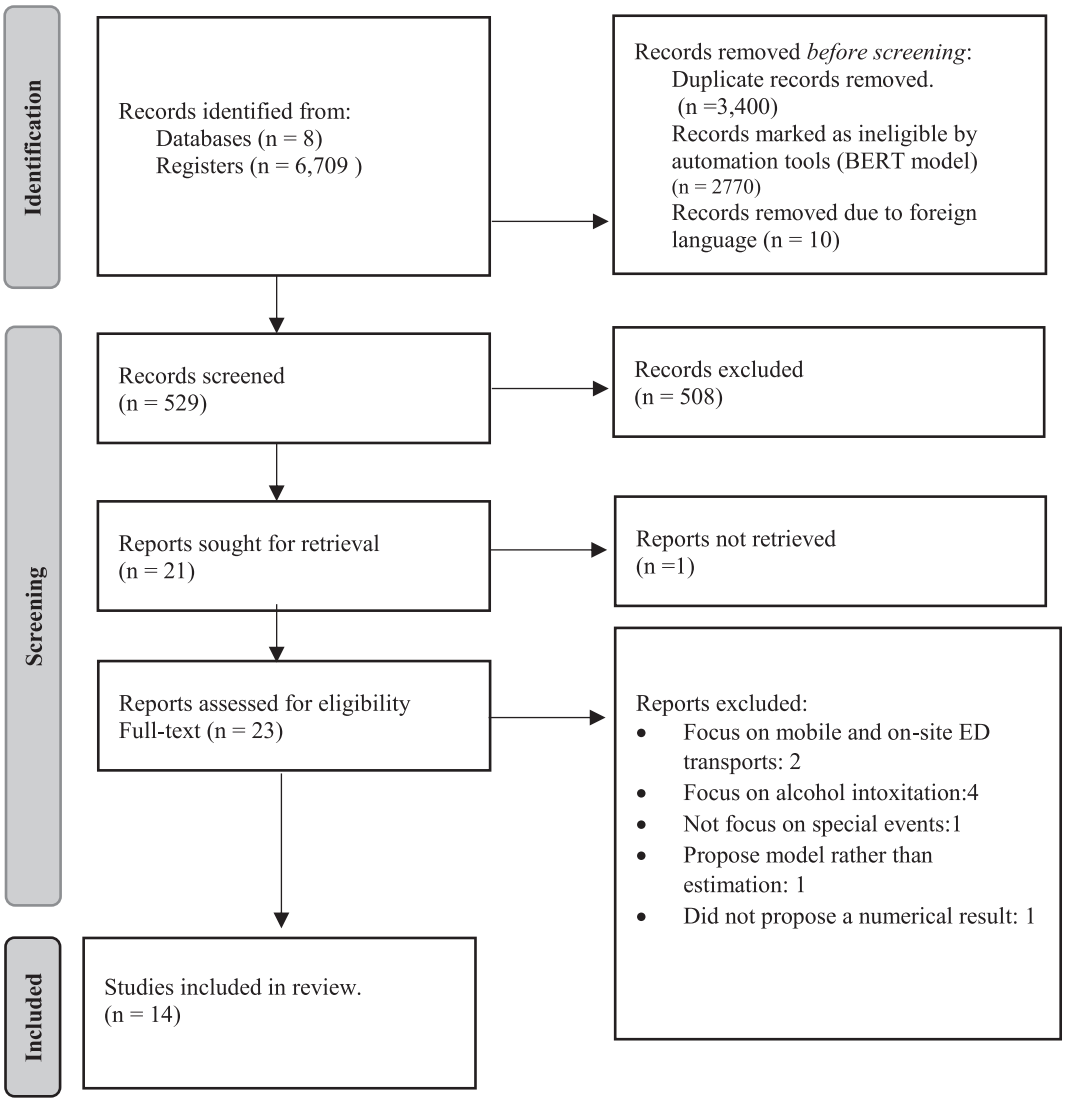
Identification
Records identified from:
Databases (n = 8)
Registers (n = 6,709)
Records removed *before screening*:
Duplicate records removed.
(n =3,400)
Records marked as ineligible by automation tools (BERT model)
(n = 2770)
Records removed due to foreign language (n = 10)
Screening
Records screened
(n = 529)
Records excluded
(n = 508)
Reports sought for retrieval
(n = 21)
Reports not retrieved
(n =1)
Reports assessed for eligibility
Full-text (n = 23)
Reports excluded:
• Focus on mobile and on-site ED transports: 2
• Focus on alcohol intoxitation:4
• Not focus on special events:1
• Propose model rather than estimation: 1
• Did not propose a numerical result: 1
Included
Studies included in review.
(n = 14)

Figure 1. Prisma flow chart on the emergency department (ED) admission effects of mass gatherings (MGs).

manual screening workload while maintaining high accuracy in identifying relevant articles. Accordingly, two reviewers independently assessed the suitability of studies identified through the literature search. In cases of disagreement, a third team member evaluated the studies to reach a final decision. After removing duplicates and screening titles and abstracts, 23 articles proceeded to full-text review. Following this comprehensive screening process, 14 studies met the eligibility criteria and were included in the systematic literature review. The combined use of BERT and manual screening proved to be an effective strategy for efficiently managing the review process while ensuring rigor.

Data Extraction

Critical data extracted from the included studies was input into a spreadsheet by one reviewer and verified by another. Extracted data included study details (author/s, year, location, design), event details (type, duration), and outcome details (ED admissions, timing relative to event). Study authors were contacted to provide missing data.. Table 1 provides an overview of all the studies selected for full-text checking and the reason for excluding particular items.

Table 2 studies information about the effect of special events on the number of ED admissions. Furthermore, Table 3 provides information on the type of ED admissions in special events and MGs.

Table 2 synthesizes the findings from studies analyzing ED presentations before, during, and after various events and MGs, influencing ED volumes over defined periods. The table divides the results into pre-event, during-event, and postevent timeframes. An "increase" indicates higher ED admissions relative to average volumes for that period, while "decreased" corresponds to reduced ED vis-

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Table 2. All Studies Included in SLR on the Effect of Special Event and Mass Gathering on the Number of ED Admissions

Author(s)	Year	Location	Study Design	Outcome Measured	Duration	Participant Age	Participant Count	Event Type	Participants Gender	Admission Type	Lessons Learned /Results	Statistical Analysis Provided	Overall Effect Analysis*		
													Pre-event	During event	Postevent
Hughes et al. (8).	2018	England, France, Northern Ireland, Wales	Retrospective, cross national	ED attendances	Jun-Jul 2016	0–4, 5–14, 15–44, 45–64, 65+ years(All ages)	Over 2 million	Sporting event	Male, female	All ED attendances, alcohol-related visits, myocardial infarction	The research suggests that healthcare metrics like ambulance and hospital admissions would align with ED attendance patterns, which remained consistent with no significant changes before, during, or after the matches.	Pre-Event (4 h before the match): OR 0.97 95% CI 0.94–0.99 During Event (2 h for most matches and extended to 3 h for the final match): OR: 0.94 95% CI 0.91–0.97 Postevent: (4 h after the match) OR 1.01 CI, 0.99–1.04	Decrease	Decrease	NS
Gardener et al.(33)	2015	New Zealand	Retrospective	Total/hourly presentations, short stay workload, admission rate, target compliance, presentation type	Sep 9 - Oct 23, 2011	Not specifically mentioned (All ED attendees)	7419	Sporting event	Not specifically mentioned (All ED attendees)	ED visits	The study found notable increases in ED activity during the event's opening and final, with a spike in alcohol-related cases during the final, stressing the need for effective planning to manage these surges.	During event (during all days with New Zealand 2011 Rugby World Cup): Overall 8% increase in Emergency Department		Increase	

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Table 2. (*continued*)

Author(s)	Year	Location	Study Design	Outcome Measured	Duration	Participant Age	Participant Count	Event Type	Participants Gender	Admission Type	Lessons Learned /Results	Statistical Analysis Provided	Overall Effect Analysis*		
													Pre-event	During event	Postevent
Zroback et al. (30)	2014	Cape Town, South Africa	Cross-sectional	Injury hospital visits, injury types, timing, trauma, mortality	31 days	<18 years	9272	Sporting event	Male, female	All EDs focused on injury and trauma-related pediatric ED	Trauma-related ED visits decreased by 37% during the World Cup, with over 2100 fewer pediatric injury visits in Cape Town. All-cause ED visits dropped 8 h before and after matches, followed by a slight increase 12 h postmatch.	ED visits dropped 16.4% prematch and around 20% during the match, followed by a 26.2% spike in admissions 12 h postmatch. ED visits dropped 16.4% prematch and around 20% during the match, followed by a 26.2% spike in admissions 12 h postmatch. ED visits dropped 16.4% prematch and around 20% during the match, followed by a 26.2% spike in admissions 12 h postmatch.	Decrease	Decrease	Increase

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Table 2. (*continued*)

Author(s)	Year	Location	Study Design	Outcome Measured	Duration	Participant Age	Participant Count	Event Type	Participants Gender	Admission Type	Lessons Learned /Results	Statistical Analysis Provided	Overall Effect Analysis*		
													Pre-event	During event	Postevent
Tommy Y. Kim et al. (27)	2012	United States	Retrospective, observational	Paediatric ED visits during sporting events	2006–2010	Not specifically mentioned (All ED attendees)	N/A	Sporting event	Not specifically mentioned (All ED attendees)	Paediatric ED visits	The study compared data to control periods a week after the events and found no significant difference in ED visits during the events, except for a decrease 6 to 8 h after the National Basketball Association (NBA) finals. It suggests that major sporting events have minimal impact on pediatric ED presentations during or shortly after the events.	Pre-event: No significant difference in ED visits between the study and control groups, with median visits of 18 and 17 for the study group compared to 16 for both intervals in the control group (*p*-values: 0.868, 0.647). During the event: No significant difference, with a median of 14 visits for the study group and 15 for the control group (*p*-value: 0.771). Postevent: No significant differences were observed in median visits across 2–8 h postevent (*p*-values: 0.802, 0.405, 0.368).	NS	NS	NS

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Table 2. (*continued*)

Author(s)	Year	Location	Study Design	Outcome Measured	Duration	Participant Age	Participant Count	Event Type	Participants Gender	Admission Type	Lessons Learned /Results	Statistical Analysis Provided	Overall Effect Analysis*		
													Pre-event	During event	Postevent
André ALMEIDA (32)	2014	Lisbon, Portugal	Retrospective	ED admissions, urgency by triage	14 periods 2008–2011	N/A	N/A	Sporting event	Not specifically mentioned (All ED attendees)	ED by triage system	The study found a 20.6% reduction in total admissions during the Lisbon football derby, mainly in less urgent cases, followed by a postmatch increase, also in less urgent cases. It offers insights into how major sports events affect emergency department usage, particularly for less severe conditions.	During the match, admissions dropped by 20.6%, mostly in less urgent cases ($p = 0.06$). Postmatch, overall admissions increased by 5.6%, with a significant 18.9% rise in less urgent cases ($p = 0.05$). During the match, admissions dropped by 20.6%, mostly in less urgent cases ($p = 0.06$). Postmatch, overall admissions increased by 5.6%, with a significant 18.9% rise in less urgent cases ($p = 0.05$).		Decrease	Increase

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Table 2. (*continued*)

Author(s)	Year	Location	Study Design	Outcome Measured	Duration	Participant Age	Participant Count	Event Type	Participants Gender	Admission Type	Lessons Learned /Results	Statistical Analysis Provided	Overall Effect Analysis*		
													Pre-event	During event	Postevent
Anssi Koski et al. (14)	2022	Finland	Retrospective register	EMS missions, reasons, urgency, timing, distribution	3 years	N/A	25,124	Mass gathering	Not specifically mentioned (All ED attendees)	EMS data for events and reference weeks	Mass gathering events significantly increase emergency services' workload, especially for EMS, with spikes in violence-related and traffic incidents, particularly in rural areas and during the evening and night. Geospatial analysis pinpointed hotspots in and around event locations, emphasizing the need for strategic resource deployment and preparedness.	During event: (two weeks before and after the events): +0.72 N change /day for A-level emergency, +2.62 in B-Level, +7.13 in C level and −2,25 in D level		Increase(All ED levels except d-level)	

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Table 2. (*continued*)

Author(s)	Year	Location	Study Design	Outcome Measured	Duration	Participant Age	Participant Count	Event Type	Partici pants Gender	Admi ssion Type	Lessons Learned /Results	Statistical Analysis Provided	Overall Effect Analysis*		
													Pre-event	During event	Poste vent
Sendoa Balles-teros Peña et al. (37)	2020	Spain	Retrosp ective	patient visits to the ED on match days and comparing them with control days	2017–2019	Not specifically mentioned (All ED attendees)	N/A	Sporting event	Not specifi-cally men-tioned (All ED atten-dees)	ED admissions	The study analysed the effect of local football matches on emergency department visits in Bilbao, Spain. Adult visits decreased by 7.5% during home matches and 8.4% during away matches, while pediatric visits dropped by 32.7% during major away games. The study concludes that football matches modestly impact emergency visits, with the effect more pronounced during significant away games.	During event: (Days and hours of match played): 32.7% (95% CI, 7.4%–68.3%) decrease in pediatric ED visits		Decrease	

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Author(s)	Year	Location	Study Design	Outcome Measured	Duration	Participant Age	Participant Count	Event Type	Participants Gender	Admission Type	Lessons Learned /Results	Statistical Analysis Provided	Overall Effect Analysis*		
													Pre-event	During event	Postevent
Johnston et al. (16)	2020	Australia	Longitudinal	ED Avoidance	12 months	Varied	N/A	ED event avoidance	N/A	Hospital admissions avoided through strategic ED management	The study showed that strategic management of emergency department (ED) services, including targeted avoidance strategies, can reduce unnecessary hospital admissions and enhance patient flow, ultimately decreasing the burden on healthcare services.	N/A	Reduced by 2%	N/A	

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Author(s)	Year	Location	Study Design	Outcome Measured	Duration	Participant Age	Participant Count	Event Type	Participants Gender	Admission Type	Lessons Learned /Results	Statistical Analysis Provided	Overall Effect Analysis*		
													Pre-event	During event	Postevent
Wong et al. (18)	2017	Canada	Observational	ED visits, trauma, intoxication	14 days	Varied	263,380 visits	Calgary Stampede	Mixed	ED and urgent care	The Calgary Stampede event led to increased ED visits, particularly for trauma, substance misuse, and violence. The study revealed that crowding during night-time and in specific demographics (e.g., men and ambulance arrivals) spiked during the event, providing insights into resource allocation during mass gatherings.	ED use increased by 2.1%	N/A	2.1% increase	N/A

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Table 2. (*continued*)

Author(s)	Year	Location	Study Design	Outcome Measured	Duration	Participant Age	Participant Count	Event Type	Participants Gender	Admission Type	Lessons Learned /Results	Statistical Analysis Provided	Overall Effect Analysis*		
													Pre-event	During event	Postevent
Almalki et al. (17)	2021	Saudi Arabia	Retrospective chart review	ED and ICU admissions, mortality	Ramadan period(Umrah Pilgrim)	N/A	566,050 visits	Mass Gathering (Ramadan)	Mixed	ED and ICU admissions	During the Ramadan period, there was a significant increase in ED visits (83% increase) and ICU admissions, particularly for acute cases. The study suggests that mass gatherings like Ramadan require improved hospital surge capacity planning to manage the increase in patient flow and prevent morbidity and mortality.	ED visits increased by 83%	N/A	83% increase	N/A

SLR = systemic literature review; ED = emergency department; EMS = emergency medical services; ICU = intensive care unit.

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Table 3. Studies Included in the Type of ED Admissions.

Author/ Admission Type	Location	Duration	Type of event	Lessons we learned/results	No of total admission	Trauma	Injuries:	Violence/ Assault injury	Medical Conditions	Substance-related:	Mental and Behavioural	Respiratory and Allergies	Pain and Discomfort
Koski et al. (14)	Finland	2015–2017	MG events	The study found varying risk ratios (RR) for hospital admissions across different scenarios. Admissions related to violence had the highest RR at 1.87 (95% CI: 1.43–2.44), while the lowest was for other diseases at 1.13 (95% CI: 0.90–1.41). The confidence interval for cardiac arrests was broader due to fewer cases. Notable increases were seen in admissions related to violence, traffic accidents, and injuries.	5949 (all cause)	N/A	2048(34% of all-cause admissions)	252(4% of all cause admissions)	N/A	N/A	N/A	56(1% of all cause admissions)	N/A
Zroback et al. (30)	Cape Town, South Africa	31 days	Sport event	The distribution of injury-related diagnoses during the World Cup varied significantly. Of 17 diagnosis types, 12 showed reductions, with the largest in 'multiple other or unspecified injury' and 'open or superficial wound or contusion.' Five diagnoses increased, with poisoning or toxic ingestion showing the largest rise. However, none of these changes were statistically significant.	51,294 (all cause admissions)	9272(18% of total admissions)	1015 pre world cup (11% of total admissions, 94% of all injury related admissions) /1484 during world cup (16% of total admissions, 92% of injury related admissions) /1001 post world cup (11% of total admissions, 94% of injury related admissions)	31 out of 1083 (pre world cup) (3% of injury related admissions, 0.1% of total admissions) / 62 out of 1620 (during world cup) (4% of injury related admissions, 0.1% of total admissions) / 28 out of 1068 post world cup (3% of injury related admissions, 0.1% of total admissions)	N/A	N/A	N/A	N/A	N/A

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Table 3. (*continued*)

Author/ Admission Type	Location	Duration	Type of event	Lessons we learned/results	No of total admission	Trauma	Injuries:	Violence/ Assault injury	Medical Conditions	Substance-related:	Mental and Behavioural	Respiratory and Allergies	Pain and Discomfort
Helen E. Hughs (8).	England. France, North Ireland	1 June–14 July 2016	Sporting event	Myocardial ischemia (MI) attendances made up 1% of all attendances in England and Northern Ireland, and 0.4% in France. Alcohol-related attendances were 0.6% in France, 0.8% in Northern Ireland, and 1.2% in England. ED attendances followed similar patterns across all countries, with the lowest numbers at night and the highest on Mondays. Alcohol-related attendances peaked on weekends, while MI attendances were highest during the week.	1821,557(All diagnosed participants)	1821,557(All diagnosed participants)	N/A	N/A	7913(0.4% of total admissions)	20,648 (1% of total admissions)	N/A	N/A	N/A
Ranse et al. (15)	Australia, Canberra	November 2014	Outdoor music festival	During a 12-hour mass gathering event, 197 participants (0.99%, 9.85 per 1000) sought health services, averaging 16.4 patients per hour. Over half (55.3%) of the patients presented between 17:00 and 21:00, with peak cases between 19:00 and 21:00. Most cases (87.8%) required only first aid, allowing participants to return to the event. Common issues included headaches (54.3%), superficial lacerations, and substance or alcohol intoxication.	173 (on-event first care aid only)	N/A	40 (23% of total admissions)	N/A	119 (69% of total admissions)	12 (7% of total admissions)	2 (1% of total admissions)	N/A	N/A

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Table 3. (*continued*)

Author/ Admission Type	Location	Duration	Type of event	Lessons we learned/results	No of total admission	Trauma	Injuries:	Violence/ Assault injury	Medical Conditions	Substance-related:	Mental and Behavioural	Respiratory and Allergies	Pain and Discomfort
M. DeMott et al. (36)	Chicago, Illinois	October 13, 2013, to December 31, 2015	MG events	In the Chicago-based study by Joshua M. DeMott et al., 71.8% of ED presentations following mass gatherings were male, with a median age of 27 years. Trauma-related cases were the most common (32.1%), followed by psychiatric (19.1%) and medical (17.2%) issues. Laboratory testing was required in 42.6% of cases, with a median length of stay of 223 min.	180(All presented in ED)	N/A	32 (18% of total admissions)	N/A	119 (66% of total admissions)	12 (7% of total admissions)	2 (1% of total admissions)	N/A	N/A

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Table 3. (*continued*)

Author/ Admission Type	Location	Duration	Type of event	Lessons we learned/results	No of total admission	Trauma	Injuries:	Violence/ Assault injury	Medical Conditions	Substance-related:	Mental and Behavioural	Respiratory and Allergies	Pain and Discomfort
Luther et al. (19)	Australia, Canberra	10:30AM on December 3, 2016 to 12:30AM on December 4, 2016.	Outdoor music festival	Over four years, a music festival with 2000 annual attendees had 54 patients receiving emergency care on Fun Day, with 33.3% needing transport to the emergency department. On-site ambulances handled 77.8% of transports, with mutual aid for the rest. The mean patient presentation rate (PPR) was 7.0 per 1000 attendees, and the transport-to-hospital rate (TTHR) was 2.0 per 1000. Intoxication was the most common issue (55.6%), followed by lacerations (13.0%) and head trauma (9.3%). The event used a successful model of care involving student responders, ambulances, and harm reduction strategies.	296	N/A	N/A	N/A	N/A	33 (11% of total admissions)	71 (24% of total admissions)	61 (21% of total admissions)	21 (7% of total admissions)

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Table 3. (*continued*)

Author/ Admission Type	Location	Duration	Type of event	Lessons we learned/results	No of total admission	Trauma	Injuries:	Violence/ Assault injury	Medical Conditions	Substance-related:	Mental and Behavioural	Respiratory and Allergies	Pain and Discomfort
Friedman et al. (20)	New York USA	2014–2017	Music Festival and Campus-Wide Celebration	At a music festival with 2000 attendees, 54 patients received emergency care, with a patient presentation rate of 7.0 per 1000. Of these, 33.3% were transported to the emergency department. The main causes for medical attention were alcohol/substance use and traumatic injuries. A collaborative model involving student first responders and contracted ambulances effectively managed mass-gathering medical care.	54	5 (9% of total admissions)	7 (13% of total admissions)	N/A	N/A	30 (56% of total admissions)	4 (7% of total admissions)	N/A	N/A
Johnston et al. (16)	Australia	12 months	ED event avoidance	Hospital admissions avoided through strategic ED management	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Wong et al. (18)	Canada	14 days	Calgary Stampede	Increased ED visits, substance abuse, trauma	263,380 ED and UC visits	19.4% trauma	12.4% injuries	N/A	N/A	23.9% substance misuse	N/A	N/A	N/A
Almalki et al. (17)	Saudi Arabia	Ramadan period	Mass Gathering (Umrah pilgrim)	Significant increase in ED visits, ICU admissions during Ramadan	566,050 ED visits	N/A	N/A	N/A	Yes	N/A	N/A	Yes	N/A

ED = emergency department; ICU = intensive care unit.

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its; "NS" denotes that no statistically significant change was observed. The pre-event window across the analyses ranged from 8 hours before the event to its start time. The event period spanned 2–3.5 hours, covering the event itself; however, definitions might differ based on each study's context and the statistical parameters used. The postevent interval lasted 4–20 hours following the event's conclusion. This table facilitates an easy comparison of ED admission trends across the studies. Volume fluctuations are observed during major public events' lead-up, duration, and aftermath, temporarily affecting local populations and activities.

In Table 3, presenting cases are grouped into broader categories based on the reasons for ED visits to understand admissions during events better. Related admission types were merged, allowing trauma cases to be divided into three major groups: violence/assault injuries, general trauma, including head trauma, and other injuries, such as those from traffic accidents, falls, burns, and lacerations. Medical conditions were kept as one overall category, covering critical issues like cardiac arrests, heart attacks, acute illnesses, and weather-related conditions. Substance abuse and mental or behavioral cases were also maintained as distinct categories. Respiratory and allergy issues were combined into one group, including conditions like asthma, breathing difficulties, and allergic reactions. Finally, unexplained or severe pain presentations were merged into a single "pain" category. This system of categorizing ED admission types allows for a comprehensive understanding of overall trends during events and MGs, facilitating analysis of which presentations increase and whether certain conditions lead to more significant patient volumes. The summarized groups simplify analysis while enabling the examination of specific admission types as needed.

Risk of Bias Assessment

The risk of bias in the included studies was assessed using a modified National Institutes of Health (NIH) Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies (latest version published in July 2021) (39). The assessment focused on critical areas such as study design, participant selection, comparability of groups, exposure and outcome assessments, follow-up rates, validity of statistical analysis, and control of confounding factors. While other quality assessment instruments like JADAD and EPOC exist, they did not apply to the methodology of this systematic literature review (SLR), which focuses on cohort and observational studies.

As shown in Appendix C, the majority of quality assessment criteria received a "Yes" rating across studies, indicating an overall low to moderate risk of bias. Specifically, all 14 studies (8,14–20,27,30,32,33,36,37) clearly stated their research objectives. Well-defined inclusion criteria were uniformly applied in 13 studies, with only Sendoa Ballesteros Peña et al. (37) receiving a "No" for this criterion. None of the studies were deemed to have a high risk of bias in critical domains like selection of participants or outcome measurement. However, none of the 14 studies provided formal sample size justifications or power analyses. Additionally, while 11 studies examined different levels of exposure in relation to outcomes, three studies (16,19,36) were not applicable for this criterion. These gaps suggest some caution in generalizing effect sizes but do not substantially undermine the core findings regarding ED admission trends. Overall, no study was excluded based on high risk of bias, and these results support a reasonably robust evidence base for drawing conclusions about how mass gatherings affect ED admissions.

Results

Description and Characteristics of Studies

A literature search identified 3309 unique citations. After reviewing titles and abstracts, 23 articles were selected for in-depth evaluation. Ultimately, 14 studies met the inclusion criteria (8,14–20,27,30,32,33,36). During the screening process, the BERT model was utilized to exclude articles that did not align with the subject based on semantic similarity between the provided keywords and the articles' titles and abstracts. Manual screening was also performed for both the inclusion and exclusion stages to ensure the validity of the screening process. To enhance accuracy, two reviewers checked all articles included or excluded from the study.

Effects of Overall ED Admissions

An analysis of seven studies in this review demonstrates how special events influence the number of ED admissions (8,14,27,30,32,33,37). Four studies identified a common trend: total ED admissions tended to decrease during these events, with reductions ranging from 7.5% to 37%, primarily due to a decline in less urgent cases. For example, one study reported a 20.6% reduction in ED admissions during a major football match, mainly because fewer nonurgent cases were presented (32). The study by Johnston et al. (16) supports this trend, showing that strategic management and discouraging nonurgent ED visits during events can further reduce unnecessary admissions. This aligns with findings from other studies indicating lower demand for nonurgent care during special events.

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However, some studies, including Wong et al. (18) and Ranse et al. (15), observed an increase in ED admissions, particularly for trauma, violence-related injuries, and substance misuse. Wong et al. (18) observed a 23.9% increase in ED visits with an ICD-10 diagnosis of substance misuse during the Calgary Stampede underscored the impact of alcohol and substance use at such events. Similarly, Ranse et al. (15). reported that mass gatherings significantly increased ambulance and ED utilization, with spikes in trauma-related cases. Almalki et al. (17) further highlighted further highlighted that the influx of Umrah pilgrims to Makkah during Ramadan can lead to a substantial rise in ED and intensive care unit (ICU) admissions, with an 83% increase in ED visits reported during that period. Regarding the effect of event type on ED admissions, some studies (8,30,32,37) observed reductions in overall ED admissions during mass gatherings, while others (14,33,27) reported increases or no significant change. Public holidays and some sporting events (8,30,32,37) displayed trends of overall ED admission reductions, while music festivals typically showed increases in ED admissions, particularly for trauma and substance misuse cases. The data suggest that while some events lead to a decrease in overall ED admissions, others, particularly those associated with higher risks of trauma and substance abuse, may cause spikes in emergency cases. Most studies show that admission rates generally return to average levels or experience minor increases postevent. These findings underscore the importance of flexible resource planning to address varying patterns of ED demand during different types of mass gatherings.

Effects on Trauma and Injury Admissions

An analysis of multiple studies reveals that trauma and injury-related admissions represent a significant portion of ED activity during mass gatherings and special events (14,15,17–19,30,36). Trauma-related ED visits strongly correlate with such events, particularly sporting events and music festivals (14,15), suggesting that injuries from violence and accidents often increase during these periods. A study in Finland (14) highlighted that 34% of all ED admissions during mass gatherings were injury-related, with 4% attributed to violence or assault, demonstrating the impact of interpersonal violence during large gatherings. Ranse et al. (15) found that trauma-related cases, including lacerations and head injuries, accounted for 23% of admissions during an outdoor music festival in Australia. In South Africa, the study of the 2010 FIFA World Cup (30) reported that 18% of total admissions during the event were trauma-related. However, the rate of violence and assault injuries remained relatively low. Some studies observed mixed outcomes; Wong et al. (18) documented a 2.1% increase in overall ED and urgent care admissions during the Calgary Stampede, with significant increases in injuries and substance misuse-related issues. Another study in Saudi Arabia on Ramadan's surge of Umrah pilgrims found a substantial rise in injury-related ED visits (17). The increase in trauma cases, including those linked to accidents and other critical incidents, underscores the need for enhanced medical preparedness.

These findings illustrate that while trauma admissions tend to increase during special events, the nature and extent of these injuries vary depending on the type of event and location. Events characterized by heavy alcohol consumption, such as music festivals, often exhibit higher rates of trauma and injury cases. The data emphasize the importance of proactive resource allocation, safety protocols, and in-event medical services to manage the rise in trauma-related ED visits during such gatherings.

Alcohol and Substance Abuse Patterns

Several studies have consistently reported that alcohol and substance use significantly impact ED admissions during mass gatherings and special events (8,14,15,18–20,33,36). These events often witness a surge in intoxicated individuals requiring emergency care, either due to direct complications from alcohol or drug use or injuries sustained while under the influence. Substance abuse and alcohol-related cases were among the main reasons for increases in ED admissions during music festivals, especially on weekends (15,19,20) and sporting events (8, 27). In contrast, religious gatherings showed minimal impact due to cultural restrictions on alcohol consumption (17). Postevent spikes in ED admissions were also noted for sporting events, lasting up to 12 hours after the event (33). Ranse et al. (15) observed a substantial number of alcohol and drug-related cases during a large-scale music festival, highlighting that these incidents contributed significantly to overall ED demand, particularly in the evening. Substance misuse and intoxication often required extended observation and care, placing additional strain on already busy ED resources.

Moreover, a review by Delany et al. (40) confirmed this pattern, reporting that alcohol and drug-related incidents accounted for up to 10% of total ED presentations during major sporting events. These cases typically involved patients with acute intoxication, many of whom required diagnostic testing or extended stays in EDs, exacerbating crowding and resource challenges. The studies reviewed underscore the significant impact of alcohol and substance-related cases on ED admissions during events where consumption is prevalent. This suggests a need for improved preparedness, such as enhanced medical staff

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Table 4. Review Findings and Novelty

Criteria	Study Findings	Study Comparison	Contributions
Emergency Department (ED) Admission Trends	Overall decrease in ED admissions, especially for low-acuity cases, during events.	Varied findings in literature; some report decreases, others note no change.	Highlights the impact of mass gatherings on healthcare utilization, underlining the importance of predictive planning.
Alcohol and Substance Issues	Increase in alcohol and substance-related ED visits during events.	Consistent with findings of increased substance use around events in existing studies.	Emphasizes the need for specific public health strategies tailored to event environments.
Trauma and Cardiac Trends	Erratic trends: some decreases attributed to preventive measures.	Contradicts the expectation of consistently heightened injury/cardiac events in some literature.	Suggests the effectiveness of safety measures and public education in mitigating adverse outcomes.

availability and targeted preventive measures, particularly during high-risk times.

Medical Conditions

Several studies indicate a consistent pattern of increased ED admissions for medical conditions, including cardiac issues, respiratory problems, and acute illnesses, during mass gatherings, particularly sporting events (14,15,17–19,30,36). Studies have indicated that mass gatherings can impact medical conditions. For instance, Almalki et al. (17) noted that the increased number of Umrah pilgrims in Makkah during Ramadan can significantly elevate ED and ICU admissions, citing an 83% surge in ED visits during that timeframe. Respiratory issues also frequently appeared, with Ranse et al. (15) reporting a significant number of asthma and allergy-related cases during music festivals. Although these medical cases constitute a smaller proportion compared to trauma and injuries, they highlight the necessity for comprehensive medical care during mass gatherings. The evidence underscores the importance of preparing for various medical conditions that can emerge during these events, particularly for vulnerable populations or attendees with pre-existing conditions (Table 4).

Other Notable Trends

Several studies identified notable trends beyond the primary focus on trauma, injuries, and substance misuse during mass gatherings (8,15,17,19,36). Respiratory issues emerged as a common concern, accounting for up to 21% of event-related emergency department (ED) visits, particularly during outdoor events where environmental factors like dust or pollen were prominent. Psychiatric issues were also reported in up to 24% of ED presentations during specific gatherings, with anxiety and stress-related conditions being the most prevalent. Geographic differences also played a role; studies showed that rural areas experienced higher admission rates than urban centers during significant events. These findings emphasize the importance of considering location-specific factors when planning healthcare resources for events and ensuring the appropriate allocation of medical staff and support services to address diverse medical needs.

Discussion

This systematic analysis provides insights into the impacts of sporting events, music festivals, and other MG) on ED utilization. A novel aspect of this study was applying the BERT natural language processing model for article screening during the full-text review stage, alongside traditional manual screening, in alignment with PRISMA guidelines. Integrating BERT facilitated a faster and potentially more accurate screening process; however, a manual review of articles was also conducted to ensure rigor and accuracy. This combined approach allowed for the evaluation of AI tools in the screening process while maintaining high standards. Although the application of AI for screening remains relatively uncommon in systematic reviews, this experience suggests that such tools can provide valuable efficiency gains. Future studies should further explore the comparative performance of AI-driven screening methods versus traditional approaches to validate their effectiveness in healthcare literature.

Multiple studies (8,16,33,32,37) found reduced overall ED volumes (by as much as 7.5–37%) during large-scale

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public events compared to nonevent periods, possibly because individuals postponed or redirected nonurgent care. In contrast, other research (15,18) highlighted increased ED attendance specifically for trauma, substance misuse, and other acute conditions. These divergent findings underscore the complexity of MGs, where cultural, environmental, and behavioral factors can shape patient presentations (12,21).

Injury-related visits often rise at events known for substantial alcohol availability or crowd density, such as music festivals and certain sporting events (14,15). Substance misuse, including alcohol intoxication, emerged as one of the top drivers of ED spikes in multiple geographies (19,20). These commonalities reinforce the need for comprehensive, context-specific mitigation strategies, such as responsible beverage service and on-site first-aid stations, that can ease the burden of acute intoxication and related injuries on local healthcare systems (36).

Another recurring pattern is the postevent surge in ED attendance, observed within 4–12 hours after certain large gatherings, especially sporting events (30,33). This deferred effect may stem from attendees presenting later for injuries or other medical concerns that initially appeared mild. By strategically scheduling additional ED staff and preparing surge capacity aligned with an event's timeline, hospitals can lessen the strain on resources when a wave of patients arrives after the primary festivities end (16,17).

The use of BERT for article exclusion based on semantic similarity provided significant efficiency benefits during the search process. Although further manual oversight was crucial to ensure relevant studies were not inadvertently dismissed, this combined technique aligns with emerging literature on hybrid AI-human approaches to systematic reviews (23–25). Such methods are especially beneficial when tackling large volumes of articles or complex search queries in healthcare research.

Despite the variety of event types and geographical coverage in the included studies, the limited sample for specific MG contexts, such as small-scale regional festivals or mass gatherings in low-income settings may limit broader generalizability. Differences in how studies define "pre-event," "during-event," and "postevent" windows further complicate direct comparisons of the timing and magnitude of ED usage changes. Standardizing temporal definitions, crowd characteristics, and outcome measures may help strengthen future analyses, while additional time-series research could better clarify the short- and long-term effects of MGs on EDs (38).

Overall, these findings confirm that MGs often prompt a decrease in nonurgent ED attendances, offset by spikes in trauma and substance misuse cases, particularly where alcohol consumption is prevalent. Recognizing this dynamic pattern is vital for effective resource planning and emergency preparedness. On-site clinical support, responsible alcohol policies, and advanced surveillance can alleviate avoidable admissions (19,20). Ultimately, evidence-based interventions anchored in local event characteristics and informed by predictive modelling tools should be prioritized to safeguard public health and maintain ED operational integrity during large gatherings (23).

Limitations

This systematic review provides insights into the effects of mass gatherings on ED admissions, but several limitations must be acknowledged. First, the limited sample size across the analyzed studies challenges the generalizability of the findings. Although the review encompasses various mass gatherings, including sporting events, music festivals, religious gatherings, and public holidays, the number of studies per event type was relatively small. Consequently, the conclusions may only partially represent the breadth of outcomes possible for some mass gatherings, especially for less frequently studied event types like religious gatherings.

Second, the geographical concentration of studies introduces potential bias. Most included research originated from high-income countries such as the United States, Australia, and parts of Europe where robust healthcare infrastructures and emergency services may shape observed outcomes. In contrast, there is limited evidence from low- and middle-income countries (LMICs), which may mask unique healthcare and cultural realities. For instance, constrained ED resources, fewer transport options, and different social norms (e.g., strict alcohol prohibitions) could markedly influence both the number and nature of ED presentations. These gaps likely understate the global spectrum of event-related healthcare needs and limit the applicability of our findings to regions with different healthcare systems, population behaviors, or public health policies. Future research explicitly targeting LMIC contexts and examining how cultural, demographic, and system-level variables affect ED utilization will be vital for a more accurate, universally applicable understanding of how mass gatherings impact emergency services.

Third, variability in event types and inconsistent reporting across studies introduce further challenges in data interpretation. Each mass gathering has unique characteristics, such as crowd size, duration, alcohol availability, and cultural norms that can influence ED outcomes. For example, sporting events and music festivals often see increases in trauma and substance abuse cases, whereas religious gatherings can exhibit minimal impacts on alcohol-related admissions due to prohibitions. These contextual factors create wide-ranging results and complicate efforts to draw firm conclusions across all event types. Differences in study methodologies, outcome measures, and reporting periods also add complexity. Another limitation

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relates to the time-based analysis of ED outcomes (pre-, during-, and postevent). While some studies provided detailed temporal data, others did not, making it difficult to assess the full impact of mass gatherings over time. This gap restricts the ability to generalize temporal trends, particularly for postevent surges that were significant in some cases but not uniformly reported.

Fourth, While certain included studies noted the potential influence of weather, explicit data on temperature, humidity, or heat waves were not consistently documented. For instance, DeMott et al. (36) observed that 88% of patients presented with at least one environmental factor (e.g., sunburn) at mass gathering events but did not systematically record weather conditions (36). Similarly, Hughes et al. (8). acknowledged that their dataset encompassed part of the European summer but did not explore high temperatures as a confounding variable. Consequently, heat-specific indicators, such as heat stroke or heat exhaustion, were largely unreported, and the prevalence of such conditions remains uncertain in this review. Future research should incorporate real-time meteorological data or validated heat indexes to determine whether extreme temperatures or humidity spikes contribute to additional ED visits. Such information is vital for designing targeted prevention measures—such as water stations, shaded rest areas, and heat alerts—that can mitigate the risk of heat-related illnesses at large-scale outdoor gatherings.

Finally, while using AI tools such as natural language processing models during the article screening process significantly improves the efficiency of identifying relevant studies, it may exclude some studies that use nonstandard terminology or phrasing, potentially limiting the pool of included articles. Manual screening remains essential to mitigate this risk, and further refinement of AI-based screening methods is needed to ensure comprehensive coverage in systematic reviews.

Conclusion

This systematic literature review provides valuable insights for emergency response planning during mass gatherings. These events draw large crowds and significantly influence healthcare utilization. The review reveals that mass gatherings often result in a temporary reduction in overall emergency department admissions, likely because attendees avoid seeking care for nonurgent cases during these events. However, there is a consistent spike in alcohol- and substance-related admissions, especially during critical periods, confirming the need for targeted public health interventions. Furthermore, while ED admission volumes tend to normalize after events, some studies identified a postevent surge in cases, which hospitals should anticipate and prepare for. Strategically planning ED capacity and staffing around these patterns, focusing on the event's peak and postevent periods, can enhance hospital preparedness. Collaborating with event organizers to implement preventive measures, such as responsible alcohol sales, harm reduction strategies, and public safety initiatives, may help reduce the healthcare burden associated with mass gatherings.

Implications for Public Health

The findings of this study present actionable opportunities for clinicians, managers, academics, and policymakers to better understand the effects of mass gatherings on emergency departments. By leveraging this enhanced understanding, stakeholders can establish effective care strategies, implement targeted public health interventions, and improve resource allocation, leading to better health outcomes and strengthened safety mechanisms within healthcare systems.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jemermed.2025.02.010.

CRediT authorship contribution statement

Ali PoshtMashhadi: Writing – review & editing, Writing – original draft, Software, Project administration, Formal analysis, Data curation. **Lincoln C. Wood:** Writing – review & editing, Validation, Supervision, Resources. **Abtin Ijadi Maghsoodi:** Writing – review & editing, Validation, Supervision, Resources, Formal analysis.

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Article Summary

1. **Why is this topic important?**
   Understanding how mass gatherings affect emergency department (ED) admissions is crucial for effective resource planning and emergency preparedness, as these events can significantly strain or alter healthcare services. By analyzing these impacts, healthcare providers can improve patient care during peak times and implement preventive measures to mitigate associated risks.
2. **What does this review attempt to show?**
   This review investigates the influence of mass gatherings on ED admissions, aiming to identify patterns and trends in overall and specific types of ED visits before, during, and after these events. It seeks to provide insights that inform emergency planning and resource allocation to enhance healthcare system readiness.
3. **What are the key findings?**
   • Mass gatherings consistently reduce total ED visits during events, mainly due to fewer low-acuity cases.
   • There is a notable increase in alcohol and substance abuse-related admissions during peak event times.
   • Postevent periods often experience a surge in overall ED volumes, indicating a delayed impact on healthcare services.
4. **How is patient care impacted?**
   • Patient care is enhanced through better resource allocation and staffing adjustments based on predicted admission patterns.
   • Targeted public health interventions can reduce substance-related admissions, alleviating strain on EDs.
   • Coordinated emergency planning with event organizers to ensure timely and appropriate care during fluctuating demand periods.

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